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First record of *Pithophora oedogonia* (Montagne) Wittrock (Pithophoraceae) in the Upper Paraná River floodplain, Brazil

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Abstract: *Pithophora* is the only genus recorded of the Pithophoraceae family in Brazil. *Pithophora* specimens were found close to banks of *Hydrilla verticillata* (L.F.) Royle in the Upper Paraná River floodplain. The specimens showed intercalary akinetes isospores in the same individual and morphologic similarities with *Pithophora oedogonia* reported in previous studies. This species constitutes a new citation for the Upper Paraná River floodplain and the third report for Brazil.

Key words: biogeography, Cladophorales, freshwater flood pulse, subtropical, taxonomy

Members of the family Pithophoraceae (Cladophorales: Ulvophyceae) are naturally tropical and occur widespread distributed from tropical to subtropical regions commonly in freshwater environments (Wittrock 1877; Boedeker et al. 2012). *Pithophora* specimens are most similar morphologically to *Cladophora*. However, sterile specimens differ from *Cladophora* by having a slightly developed system of ramification and fertile specimens by having akinetes, the taxonomic character most important for its identification (Wittrock 1877).

There are few records of Pithophoraceae in Africa and South America (Wittrock 1877; Boedeker et al. 2012) and in Brazil particularly, *Pithophora* is the only genus listed of this family. Currently, 20 species of *Pithophora* are known, which have broad geographic distribution (Bicudo and Menezes 2006). However, because to overlap of morphological characters, all taxa could be synthetized into only two species: *Pithophora oedogonia* (Montagne) Wittrock and *P. roettleri* (Roth) Wittrock (Pankow and Täuscher 1980). The morphologic characteristic that separates these two species is the shape of the intercalary akinetes. In *P. oedogonia*, the akinetes have similar shape in the same individual (isospores), whereas in *P. roettleri* there are different forms of akinetes in the same individual (heterospores) (Wittrock 1877; Skinner and Entwisle 2004).

Pithophora specimens may be found in the littoral zone of lentic or semi-lentic environments, where they form floating masses. In the floodplain of the Upper Paraná River, despite its high algal richness (see Agostinho et al. 2009), members of Pithophoraceae were not recorded in previous studies on periphyton and phytoplankton communities.

The Upper Paraná River floodplain is an important conservation area located between Porto Primavera Dam and Itaipu Reservoir, extending about 230 km in length (Agostinho et al. 2009). Samples (n=3) were taken on 30 November 2012 in the main channel of the Paraná River (22°40′–22°50′ S; 053°10′–053°20′ W; Figure 1). In general, in this period the Upper Paraná River had warm water with mean temperature about 31°C, mean pH close to neutral (7.09), mean alkalinity 320.9 mEq·L^{-1}, mean conductivity 49.6 µS·cm^{-1} and mean N:P ratio 27.

The material described in the present study was firmly attached and entangled to banks of *Hydrilla verticillata* (L.F.) Royle and to the surface of stones (Figure 2) at an average depth of 0.60 m. The material was preserved in Transeau solution, at the proportion 1:1 (Bicudo and Menezes 2006). Species identification was based on classic literature (Wittrock 1877; Bourrelly 1990; Skinner and Entwisle 2004; Franceschini et al. 2006). The vouchers were deposited in the Herbarium of the State University of Maringá (25743 - HUEM), Brazil.

Phylum Chlorophyta
Class Ulvophyceae
Order Cladophorales
Family Pithophoraceae

Pithophora oedogonia (Montagne) Wittrock (Figures 3–12 and 13) — Macroscopic alga, branched; thallus

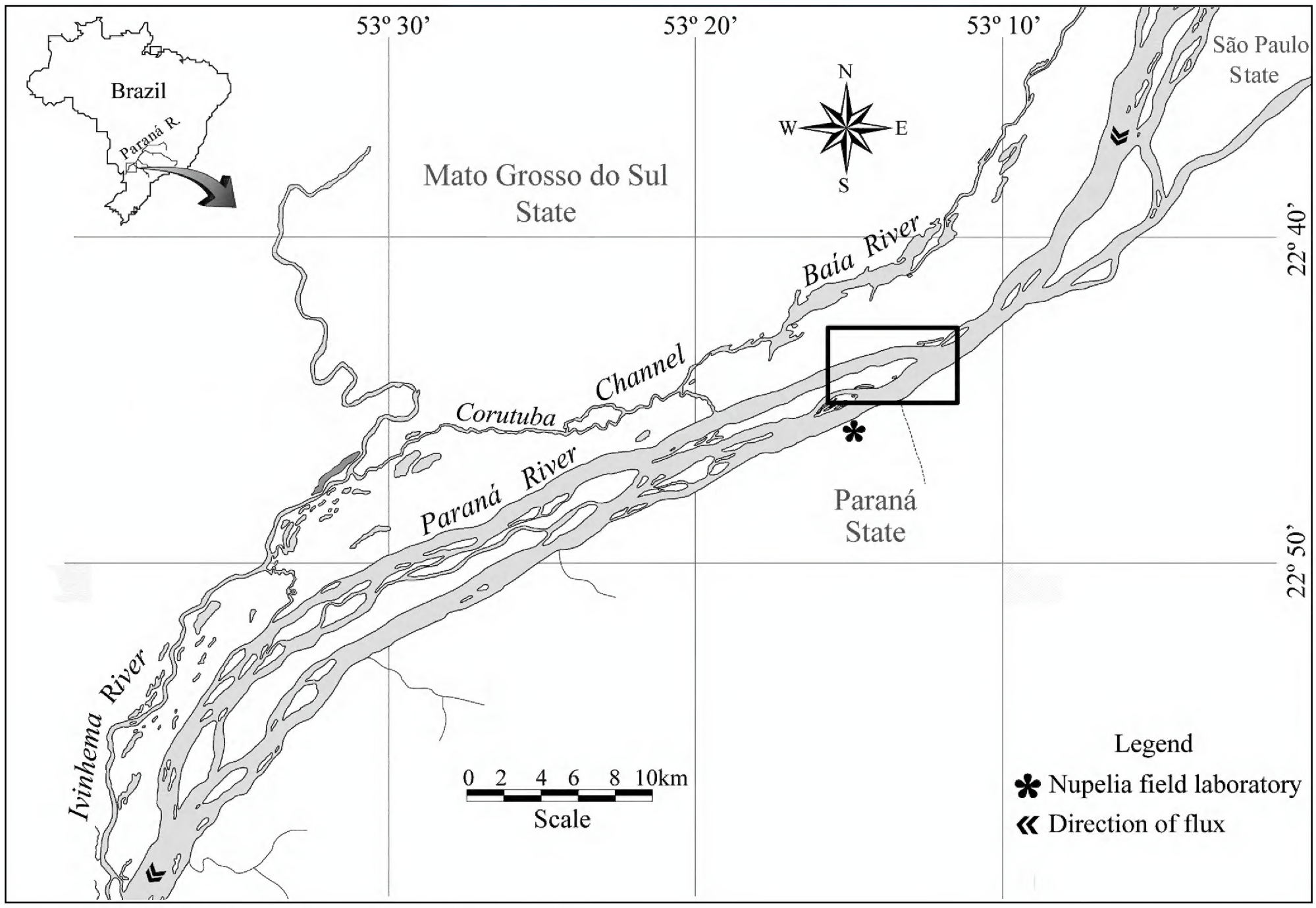


Figure 1. Upper Paraná River floodplain and location of site studied.

cylindrical and uniseriate. Cell wall thick, 2.0–2.5 µm. Vegetative cells cylindrical, longer than wider, varying on the main branch from 9.4 to 17.7 times (length: 612–1683 µm; width: 65–95 µm). Apical vegetative cells conical-rounded (length: 1009.8–1555.5 µm; width: 60–80 µm). Presence of several intercalary and terminal akinetes, with the same shape along the individual. Intercalary akinetes may occur in sequence of two or three and present a cylindrical or doliform (barrel) shape (length: 170.0–383.13 µm; width: 69.3–157.5 µm). Terminal akinetes solitary, cylindrical, elongated or doliform, with apex conical-rounded (length: 212.5–326.7 µm; width: 85–140 µm). Branching degree varies from first to fourth order, occurring unilaterally and bilaterally, alternate and/or opposite. Branching occurs at an average of 16.5 µm from the transverse septum of the vegetative cells and as well occurs close to intercalary akinetes or above them, originating unilateral and/or bifurcated thallus, with cells with 510–1683 µm in length and 51-75 µm in width. Chloroplast single, parietal, reticulate and with numerous pyrenoids irregularly dispersed.

We observed several times the germination of intercalary akinetes and the formation of branches on them, as well as intumescence in the vegetative cell close to the transverse septum with the accumulation of reserve material, as recorded by Wittrock (1877) and Bourrelly (1990). We also observed the sporadic presence of well developed rhizoids and helicoids, formed by irregularly shaped, slightly branched cells, and occurring along the main branch and on branch extremities.

Remarks: Contrary to the report by Franceschini et al. (2006), in this study *Pithophora oedogonia* specimens were found in alkaline and neutral pH waters and, in general, our specimens were larger than those recorded by these authors. Our specimens conform well to Wittrock's (1877) description of *P. oedogonia* in that in general, they possess regularly branches of three degree, that occur germination of the intercalary akinetes, and

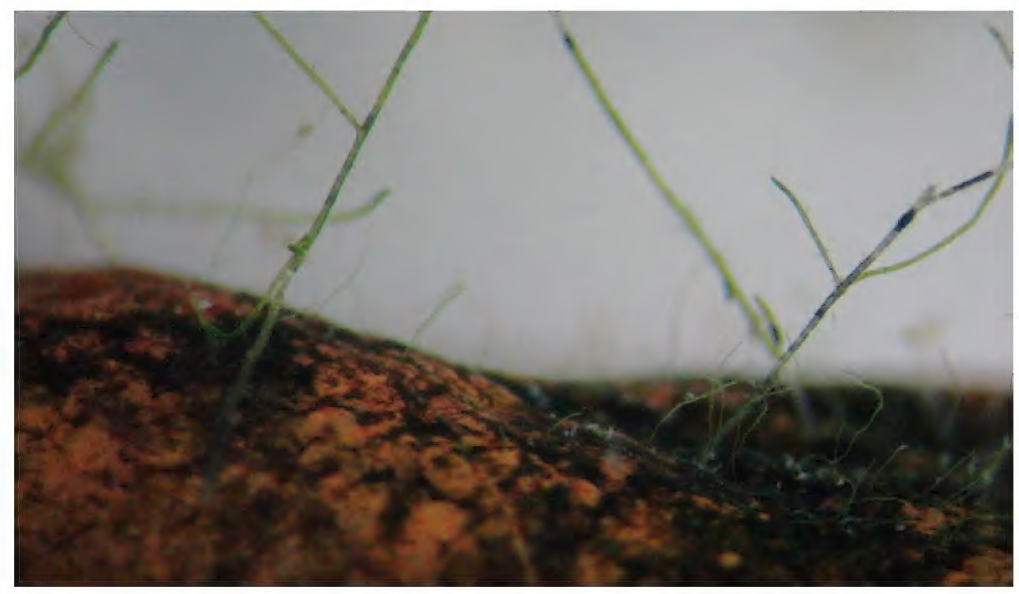
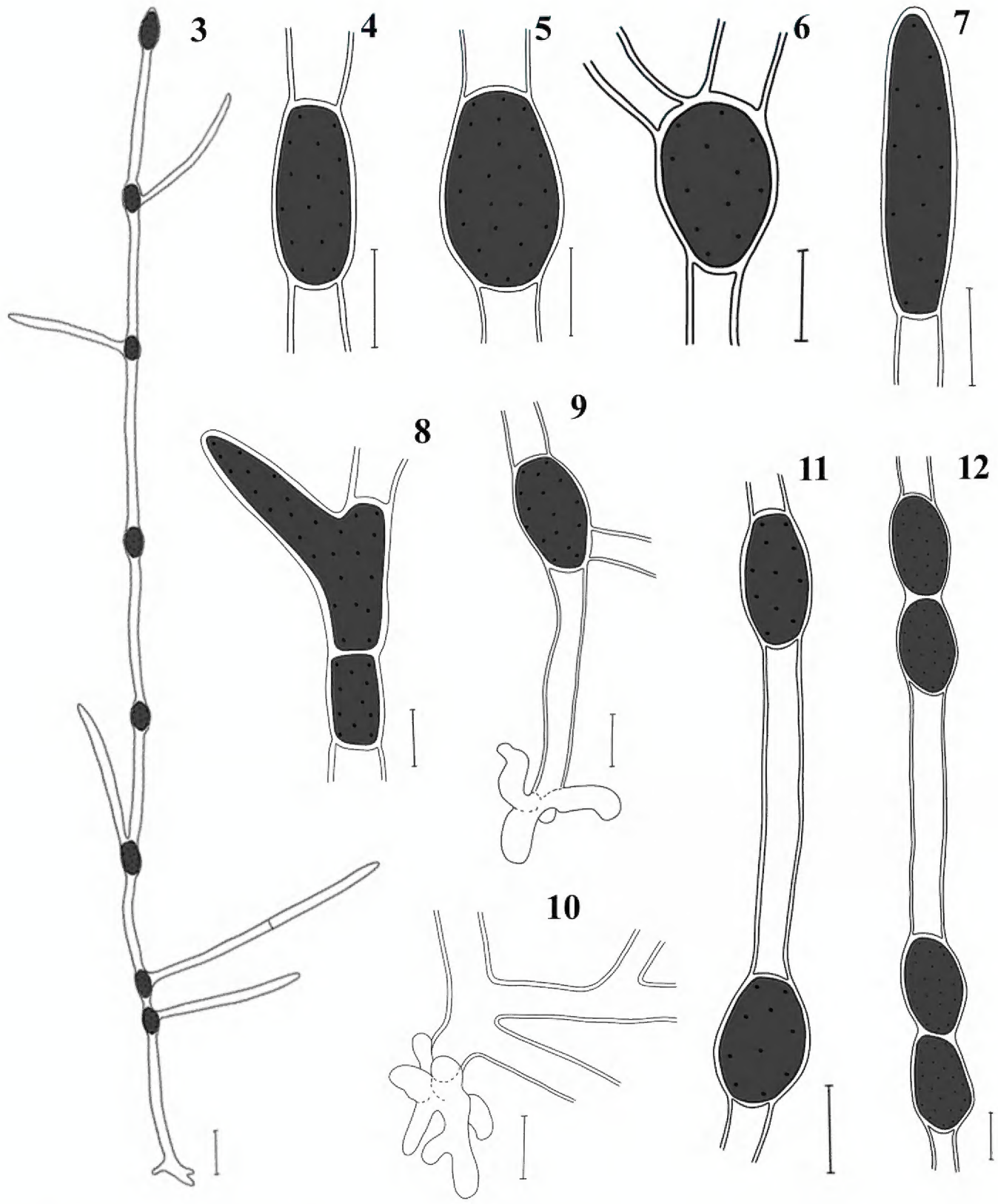


Figure 2. Overview of the *Pithophora oedogonia* attached to the surface of the stone.



Figures 3–12. First record of *Pithophora oedogonia* (Montagne) Wittrock (Pithophoraceae) in the Upper Paraná River floodplain. **3**: *Pithophora oedogonia* Wittrock. **4–6**: Intercalary akinetes; (4) cylindrical shape akinete; (5 and 6) doliform shape akinetos. **7**: Terminal akinete. **8**: Germination of intercalary akinetes. **9–10**: Rhizoids. **11–12**: Intercalary akinetes; (12) twin akinetes. Scale bar: 10 µm.

subsporal cells are rich in reserve material. Our results also confirm that the species occurs in warmer water, in a subtropical region and grows together with several genera of aquatic macrophytes.

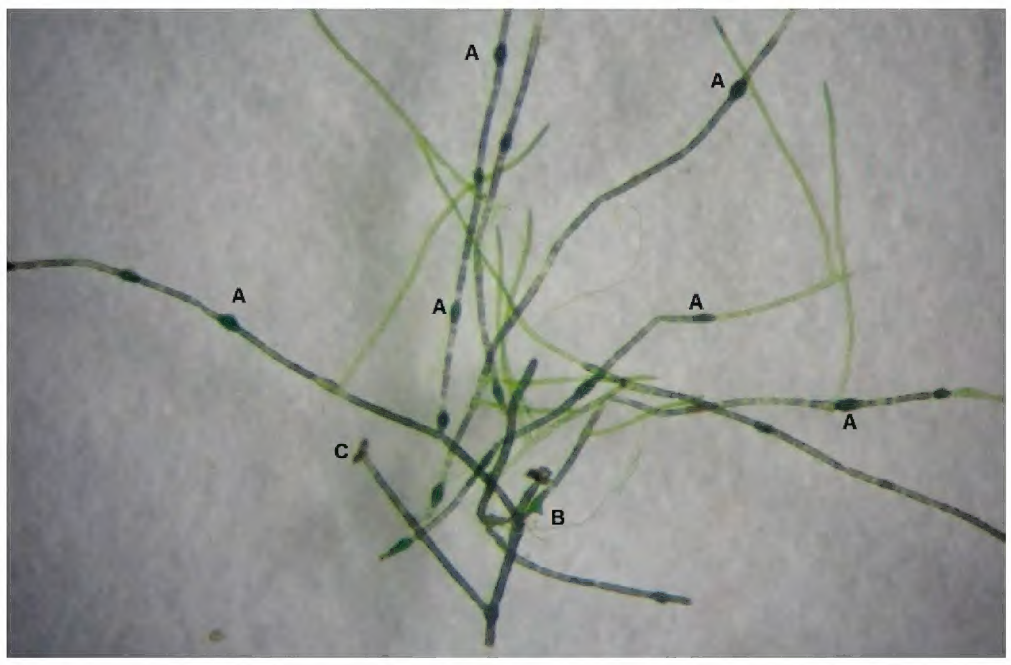


Figure 13. Overview of the *Pithophora oedogonia*. **A**: Intercalary akinetes. **B**: Germination of intercalary akinetes. **C**: Rhizoid.

Geographic distribution for Brazil: Porto Alegre, state of Rio Grande do Sul (Franceschini et al. 2006) and Mato Grosso, central Brazil (Freitas and Loverde-Oliveira 2013).

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Authors' contribution statement: VMA, BD, AB and LR analyzed, identified the specimens and wrote the text, VMA, BD and AB described the specimens, AB illustrated.

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